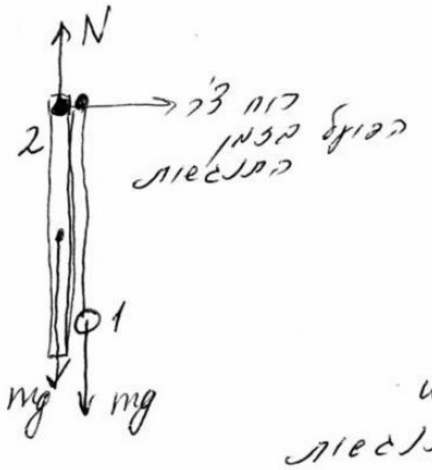

שימור אנרגיה

$$\frac{I_1 \omega_1^2}{2} = \frac{I_2 \omega_2^2}{2} \quad (1)$$

ω_1 — מהירות זוויתית הכדור רגע לפני התנגשות

ω_2 — מהירות זוויתית המוט רגע אחרי התנגשות

שימור תנע זוויתי

$$I_1 \omega_1 = I_2 \omega_2 \quad (2)$$

מ- (1) ו- (2):

$$I_1 = I_2$$

$$\frac{mL^2}{3} = ml^2 \Rightarrow \boxed{l = \frac{L}{\sqrt{3}}}$$

$$dmv + \underset{=0}{I_1 \omega_1} = dmu + I_1 \omega_2 \quad ; \; I = \frac{MR^2}{2}.$$

(c

$$\omega_2 = \frac{dm(v-u)}{I_1} = \frac{0.15 \cdot 0.01\,(400-200)}{2 \cdot 0.2^2/2} = 7.5\ \frac{rad}{sec}$$

(d

$$\Delta E = \frac{mv^2}{2} - \frac{mu^2}{2} - \frac{I_1 \omega_2^2}{2} = 598.875\ J$$

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We choose to consider a system which is composed of the small mass, and the rigid body.

a. Conservation:
   - Since there are no external forces – Linear momentum of the entire system is conserved.
   - Since there's no external torque – Angular momentum is conserved.
b. Conservation of linear momentum implies:

$$\vec{p}_i = mv_0\hat{x}$$
$$\vec{p}_f = 4mu\hat{x}$$
$$\rightarrow u = \frac{v_0}{4}$$

c. To find the force, let us first find he angular momentum, with respect to an axis positioned in the center of mass (we talk about the center of mass after the collision, i.e. at the center of the pole). Conservation of angular momentum implies:

$$L_i = \frac{mv_0L}{2}$$
$$L_f = I\omega$$
$$I = 2\left(2m\left(\frac{L}{2}\right)^2\right) = mL^2$$
$$\Rightarrow \omega = \frac{v_0}{2L}$$

   We can think of the motion as a linear motion of the center of mass plus a circular motion around the center of mass. Thus, in the center of mass coordinate system, we merely see a circular motion about the center of mass, with a radius which is equivalent to the distance from the CM.

   As already said, in this coordinate system the particles obey circular motion with the above ω, and a radius $R = L/2$. Thus, we may write for each particle of mass $2m$:

$$\sum F_r = 2m\omega^2 R = \frac{mv_0^2}{2L}$$

   As the pole is the only thing which exerts a force on the particles, we conclude that the pole exerts on each particle a force which is equivalent to:

$$F = \frac{mv_0^2}{2L}$$